DOCUMENT DATA FORM Your Name: Nick Carino 502-L

Document Title or Description (max. 254 characters): Circle: Same as cover (or fill in below)

Design Calculations for Floor Trusses (incomplete set)

Include work order no. and floor no. if applicable

Roll # (e.g., CORR-4): RD-1	Doc. ID (report #, dwg. #):	
Document Date: 1967	Document Author Name:	Author Organization: Laclede Steel

KEYWORDS – HIGHLIGHT ALL THAT APPLY

Level 1

Bankers Trust	Project 6	WTC 4 - South Plaza Bldg.
Concourse	Project 7	WTC 5 - North Plaza Bldg.
Electrical Substation	Project 8	WTC 6 - Customs House
Liberty Plaza	WFC 1 - Oppenhiemer Dow	WTC 7
PATH Station	WFC 2 - Tower B	WTC Complex
Project 1	WFC 3 - American Express	WTC Plaza
Project 2	WFC 4 - Tower D	
Project 3	WTC 1 - North Tower	Add
Project 4	WTC 2 - South Tower	
Project 5	WTC 3 - Marriot Hotel	

Level 2

Accident analysis & risk	Mech./elec.	Add
Architectural	News coverage	
Data request	Police	
Emergency management	Security	
Evacuation	Structural	
Fire protection	Tenant alterations	
Fire service		

Level 3

1993 explosion	Deck	Human comfort	Splices
A/E fitout	Deflection	HVAC	Sprinkler
A-242	Demolition	Index	Stability
A-36	Design	Inspection	Stairways
A-497	Doors	Insulation	Standards
Air cooled condensers	Drawings	Joist	Steel
Analysis	Eastern States Steel	L-50	Steel composition
Angles	Egress	Loads	Stiffness
Antenna	Elevator	Maintenance	Structural review
Artifacts	Emergency communications	Marking	Survivor
Asbestos	Equipment	Mesh reinforcement	Tenant list
Beams	Escalator	Model	Testing
Bow tie	Exterior columns	Mullion	Tie
Bracing	Fabrication	Operations	Triad
Bridging truss	Family member	Paint	Truss
Calculations	Fire alarms	Partition layout	Vestibule
Carpet	Fireproofing	Photos	Vibration
Ceilings	Fire spread	Pipes	Walls
Chillers	Flammability	Plumbing	Water supply
Cladding	Floor	Probability, uncertainty	Weather
Collapse	Floor load	Reinforcing (strengthening)	Weight
Columns	Floor slab	Renovation	Weld size
Communication systems	Floor system	Repair	Wind
Composite truss	Floor trusses	Safety	Windows
Computer output	Foundations	Security system	Yield strength
Computer program	Frame	Shear knuckle	
Concrete	Frame analysis	Shear test	Add
Connections	Frequency	Shop drawings	
Construction	Fuel	Shortening	
Contract	Furniture layout	Slurry wall	
Core beams	Generators	Smoke control	
Core columns	Guidelines	Smoke test	
Dampers	Gypsum board	Spandrel beam	
Debris	Hat truss	Specifications	

LACLEDE STEEL COMPANY CONTENTS Index 1

LACLEDE STEEL COMPANY
STRUCTURAL DETAILS
WORLD TRADE CENTER TOWERS
PORT OF NEW YORK AUTHORITY

Detail No.	Title	Date Transmitted	Approved
ST-101	Typical 32" composite truss web Intermediate Panel - Full Scale		
ST-102	Typical web chord sections 32" composite trusses - Full Scale		
ST-103	Intermediate panel details 24" standard trusses 32" composite trusses - Full Scale		
ST-104	Intermediate panel details 28" composite trusses 32" composite trusses - Full Scale		
ST-105	Corner intersection details Continuity of 32" - 60' span composite trusses (CT3, CT3A and CT4) into 28" composite trusses (CT9) in 35' span - Full Scale		
ST-106	Typical column bearing end detail of 32" composite trusses 2" x 2" damping unit extension Scale ½" = 1"		
ST-106A	Column bearing end detail showing diagonal angle bracing attachment 32" composite trusses Scale ½" = 1"		
ST-106B	Column bearing end detail Typical extended shallow bearing end - 32" composite trusses Scale ½" = 1"		
ST-106C	Column bearing end detail showing damping unit extension for 28" composite trusses 24" standard trusses Scale ½" = 1"		

Detail No.	Title	Date Transmitted	Approved
ST-106D	Column bearing end detail showing diagonal angle bracing attachment 28" composite trusses 24" standard trusses Scale ½" = 1"		
ST-106E	Column bearing end detail Typical extended shallow bearing end 28" composite trusses 24" standard trusses Scale ½" = 1"		
ST-107	32" composite truss details Approximate 60' span Type CT1, CT2, CT3, CT3A and CT4 - Scale 1½" = 1'0"		
ST-108	32" composite truss details Approximate 35' span Type CT5 and CT6 Scale 1½" = 1'0"		
ST-109	28" composite truss details Corner construction Type CT7, CT8 & CT9 Scale 1½" = 1'0"		
ST-110	24" standard truss details 20'0" transverse ST8, ST10, ST11 and ST12 (duct) 13'4" transverse ST13 Scale 1½" = 1'0"		

LACLEDE STEEL COMPANY
FLOOR GRID PANEL & PANEL LOCATIONS
WORLD TRADE CENTER TOWERS
PORT OF NEW YORK AUTHORITY

Detail No.	Title	Date Transmitted	Approved
L-100	Typical floor plan - showing panel designation, truss location, applicable design moments and end reaction for truss design - Scale 1/8" = 1'0"		
L-101	Quarter plan - Typical floor showing panel designation, truss loaction, truss designation and truss web configuration Scale 1/8" = 1'0"		

LACLEDE STEEL COMPANY
DESIGN CALCULATIONS
WORLD TRADE CENTER TOWERS
PORT OF NEW YORK AUTHORITY

Sheet No.	Design Data	Date Transmitted	Approved
D100-1 thru 7	Basic Design Data		
D101	Chord Angle Properties 2" x 1/2" angles		
D102	Chord Angle Properties 3" x 2" angles		
D103	Round Web Properties		
D104	Miscellaneous Section Properties		
D105-T1	Design Data Truss Mk. 2C32T1		
D105-T2	Design Data Truss Mk. 2C32T2		
D105-T3	Design Data Truss Mk. 2C32T3		
D105-T3A	Design Data Truss Mk. 2C32T3A		
D105-T4	Design Data Truss Mk. 2C32T4		
D105-T5	Design Data Truss Mk. 2C32T5		
D105-T6	Design Data Truss Mk. 2C32T6		
D105-T7	Design Data Truss Mk. C28T7		
D105-T8	Design Data Truss Mk. C28T8		
D105-T9	Design Data Truss Mk. C28T9		
D105-T10	Design Data Truss Mk. S24T10		
D105-T11	Design Data Truss Mk. S24T11		
D105-T12	Design Data Truss Mk. S24T12		
D105-T13	Design Data Truss Mk. S24T13		
D105-ET1	Design Data Extended End Truss Mk. 2C32ET1		
D105-ET2	Design Data Extended End Truss Mk. 2C32ET2		
D105-ET3	Design Data Extended End Truss Mk. 2C32ET3		

LACLEDE STEEL COMPANY

Index 5

Sheet No.	Design Data	Date Transmitted	Approved
D105-ET3A	Design Data Extended End Truss Mk. 2C32ET3A		
D105-ET4	Design Data Extended End Truss Mk. 2C32ET4		
D105-ET5	Design Data Extended End Truss Mk. 2C32ET5		
D105-ET6	Design Data Extended End Truss Mk. 2C32ET6		
D105-ET7	Design Data Extended End Truss Mk. C28ET7		
D105-ET10	Design Data Extended End Truss Mk. S24ET10		

WORLD TRADE CENTER
FLOOR GRID TRUSSES
BASIC DESIGN DATA

Based on double truss units. Mark 2CT__ or 2ST__.
Single truss components. Mark CT__ or ST__.

DIMENSIONS:

Unless specifically noted otherwise, see "ST" Details.

Truss clearspan in feet = L. Overall length of truss minus end bearings in feet (2 x 5" = 10"). Example: 59'9" overall length. Clearspan L = 59'9" minus 10" or 58'11" or 58.92'.

Length of member, clear of attachments = "ℓ"

Depth of Truss

Composite type "C" (Measured top of shear member to bottom of lower chord.)

Standard type "S" (Measured out to out of chord members.)

Total depth of composite section = "D_t"

TOLERANCES:

Overall length 1/4"+ or 1/4"-.

Depth 1/8"+ or 1/8"-.

LOADS:

Total load = Live load + Dead load

Applicable for composite design.

Applicable for combined slat and top chord design and bottom chord design.

Construction load = Applicable Dead load

Applicable for top and bottom chord steel design.

Dead load = Actual weight of structural system in pounds per square foot.

Live load = Assigned live load for panel area in pounds per square foot.

Design load in pounds per square foot = "w"

Applicable design load in pounds per foot equals design load in pounds per square foot times spacing of trusses in feet = ... "W"

TOTAL MOMENT:

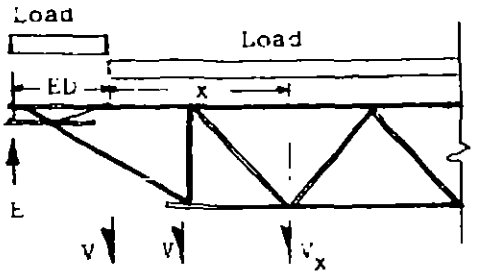
"M" (In inch pounds) = WL^2 x 1.5.

END REACTION:

"R" (In pounds) = "W" x .5 (overall length of truss in feet).

SHEAR:

At first top chord panel in pounds = V = R- (W x ED)

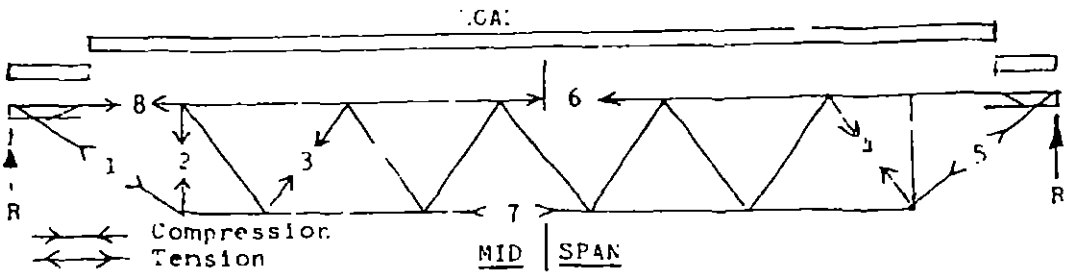


ED = Distance first top chord panel point to truss end.

Shear at other points in pounds = V_x = (R- E" x W)-W (distance to first top chord panel point in feet).

(In no case less than 50% of end reaction "R".)

DESIGNATION OF MEMBERS:



1. End diagonal (long end) tension member
2. First panel vertical (long end) compression
3. Second panel compression diagonal
4. First panel verter (short end) compression
5. End diagonal (short end) tension
6. Top chord critical compression member at mid span
7. Bottom chord critical tension member at mid span
8. End top chord compression member (long end)

MATERIALS:

A-36 steel . . . . . 36 ksi minimum yield strength

A-441 modified . . . . . 50 ksi minimum yield strength low alloy "H" Series.

See sheets D101 through D103 for Properties of Sections.

APPLICABLE FORMULAE: Stress Determination (Web or Chord Members)

A-36 steel

(36 ksi minimum yield)

f_y = Minimum Yield Strength 36,000 psi

f_s = Tension 22,000 psi

f_{sc} = Compression for $\ell/r < 127$ $\quad 18{,}540 - .574\,(\ell/r)^2$ psi

for $\ell/r > 127$ $\quad \dfrac{149{,}000{,}000}{(\ell/r)^2}$ psi

ℓ = clear distance between attachments

r = least radius of gyration

A-441 steel

(50 ksi minimum yield)

f_y = Minimum Yield Strength 50,000 ksi

f_s = Tension 30,000 psi

f_{sc} = Compression for $\ell/r < 108$ $\quad 25{,}750 - 1.108\,(\ell/r)^2$ psi

for $\ell/r > 108 < 200$ $\quad \dfrac{149{,}000{,}000}{(\ell/r)^2}$ psi

Continuous members shall be designed for only axial compressive stress when the panel length clear of attachments does not exceed 24". When the panel length clear of attachments exceeds 24", the top chord shall be designed as a continuous member subject to combined axial and bending stress and shall be of proportion that the quantity -

$$\frac{f_a}{30{,}000} + \frac{f_b}{F_b}$$

does not exceed unity at the panel point, or that the quantity -

$$\frac{f_a}{F_a} + \frac{f_b C_m}{F_b\left(1 - \dfrac{f_a}{F'_e}\right)}$$

does not exceed unity at the mid panel.

Permissible axial unit compressive stress = "F_a"

Permissible bending unit stress = "F_b"

Permissibl compressive stress factor (column equation $\dfrac{149{,}000{,}C}{(\ell/r)^2}$: psi) = "F'_e"

Actual axial unit compressive stress = ... f_a

Actual bending unit stress = ... f_b

MAXIMUM SLENDERNESS RATIOS:

Top chord panels (interior) = 85
Top chord end panels = 120
Compression members other than top chord = 200
Tension members = 240

FILLERS OR TIES:

Members in compression composed of two components shall have fillers or ties spaced so that the ratio of ℓ/r of each component shall not exceed the ratio of ℓ/r of the whole member. The minimum "r" shall be used in calculating the critical ratio ℓ/r of any component.

SHEAR CONNECTORS:

Shall be considered to provide a minimum 15 ksi horizontal shear per web end connector imbedded in the concrete. This is for 3,000 psi concrete. (f_c)

DEFLECTION:

Applicable deflection formula for uniform load.

Maximum deflection $\Delta = \frac{25.88\ (WL^4)}{29{,}000{,}000I}$

COMPOSITE SLAB AND JOIST DESIGN:

Design values

Total depth of combined slab and truss in inches = ... D_t

Effective width of concrete flange in inches equal to 2 x 8t = ... B_{eff}

Distance from top of concrete flange to neutral axis of concrete flange = ... y_1

Distance from top of concrete flange to neutral axis of top chord angles = ... y_2

Distance from top of concrete flange to neutral axis of bottom chord angles = ... y_3

Distance from top of concrete flange to neutral axis of composite section = ... y

Distance from neutral axis of composite section to neutral axis of concrete flange = ... d_1

Distance from neutral axis of composite section to neutral axis of top chord angles = ... d_2

Distance from neutral axis of composite section to neutral axis of bottom chord angles = ... d_3

Distance from neutral axis of composite section to outermost fibers of compression chord = ... c_1

Distance from neutral axis of composite section to outermost fibers of tension chord = ... c_2

Allowable concrete strength f_c = 3,000 pounds psi.

Allowable steel strength = ... f_s

Allowable concrete compressive stress f'_c = 1,350 pounds psi.

Actual concrete compressive stress = ... f'_{cc}

Allowable steel compressive stress = ... f_{sc}

Modular ratio = 15 = ... $\frac{E_s}{E_c}$

SECTION PROPERTIES: (Refer to Sheets D101 through D103)

Moment of inertia of concrete = ... I_c

Moment of inertia of top chord angles = ... I_{TCA}

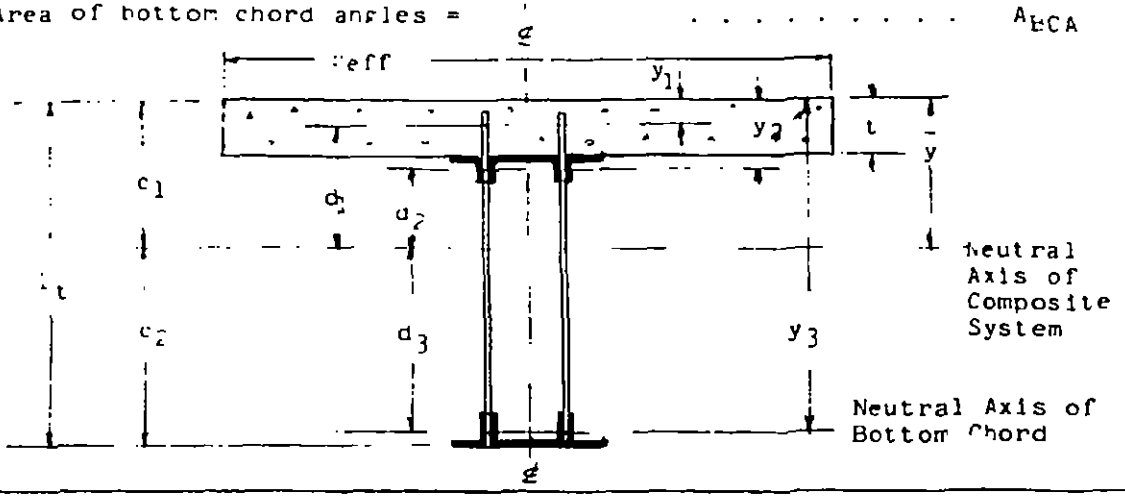
Moment of inertia of bottom chord angles = ... I_{BCA}

Moment of inertia of composite system = ... I_S

Area of concrete flange = ... A_c

Area of top chord angles = ... A_{TCA}

Area of bottom chord angles = ... A_{BCA}



FORMULAE:

Resisting moment = "RM"

Allowable unit stress times the applicable Section Modulus = (applicable f x S).

Section Modulus about the axis of bending = $S = \frac{I}{C_1 \text{ or } C_2}$

QUALITY CONTROL AND INSPECTION:

Material Test Reports

Since all steel employed in the fabrication of trusses is produced in the furnaces and mills of Laclede Steel Company, certified mill test reports showing heat numbers, chemistry, and physical properties for all steel components will be provided.

Resistance Welding

Truss panel points will be connected by electronically controlled resistance welding providing two times the strength of the connected members at full design load.

Angle chords of carbon and alloy steel to be of weldable grade with contact surfaces cleaned of scale by shot blasting prior to welding.

Welds to be subject to "on-line" testing by measured hydraulic wedge action tester with spot checking of finished panel point welds by testing in vertical double shear to two times design load value.

Any panel point welds indicated to have less than the established factor for weld shear strength will be arc welded, subsequent to testing.

Full design load tests will be effected on full size and full length truss components by hydraulic loading in a test frame with load measurement by electric load cell and center span deflection check.

Load tests with recorded deflection and recovery data will be made on a minimum of one of each identified truss style involved in the panel construction.

Physical Tension Tests

Tension tests on truss components, chord angles, and webs will be performed on selected sample members included in the normal truss fabrication.

Inspection and Access to Plant

Free access to the plant of the truss manufacturer and the

available inspection and test facilities will be offered the qualified inspectors representing the purchaser for observation of the test and inspection procedures outlined herein.

Any testing requested beyond that identified herein shall be for the account of the purchaser.

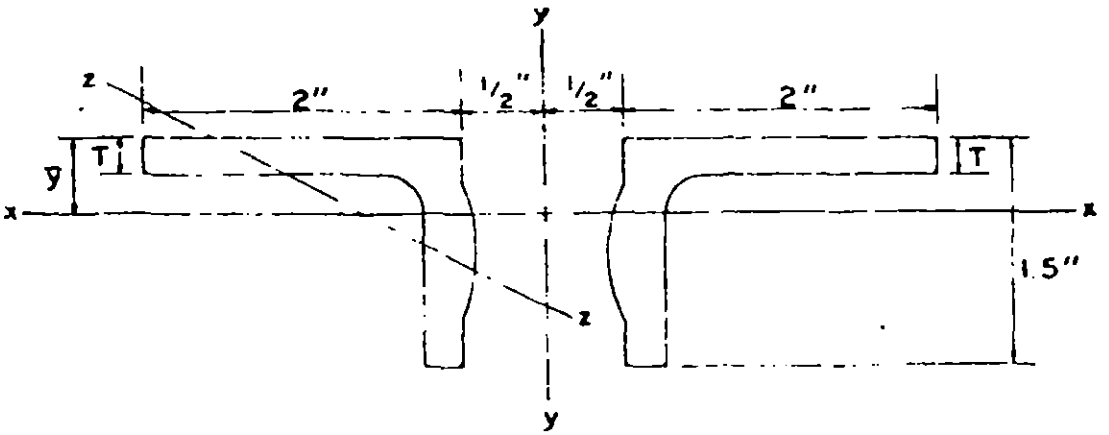
LACLEDE STEEL COMPANY SAINT LOUIS, MISSOURI

DRAWING NO D101 SUBJECT WORLD TRADE CENTER TOWERS

BY L.J.S DATE 2-6-67 THE PORT OF NEW YORK AUTHORITY

CHKD BY A.C.W DATE 2-7-67

TRUSS SECTION COMPONENTS
TRUSS ANGLE SECTIONS
DESIGN SECTION PROPERTIES



2"x 1½" x T

T					
AREA					
$\bar{y}$					
I_x					
I_y					
r_x					
r_y					
r_z (ONE ANGLE)					
LBS/FT (TWO ANGLES)					

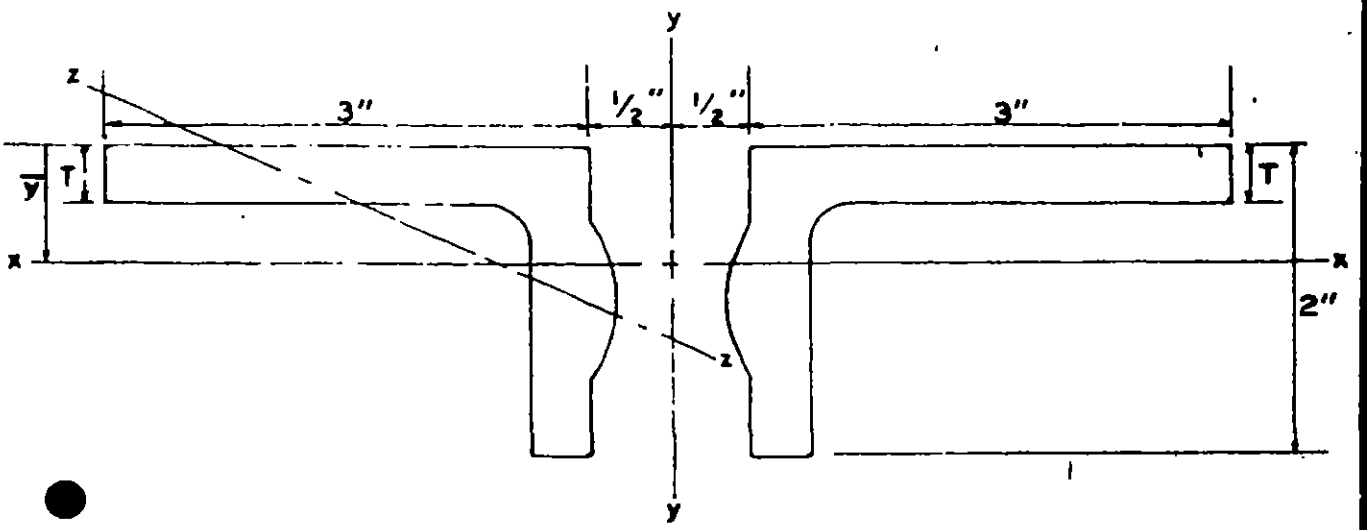
LACLEDE STEEL COMPANY SAINT LOUIS, MISSOURI

DRAWING NO. D102 SUBJECT WORLD TRADE CENTER TOWERS

BY L.J.S. DATE 2-6-67 THE PORT OF NEW YORK AUTHORITY

CHKD. BY A.C.W DATE 2-7-67

TRUSS SECTION COMPONENTS
TRUSS ANGLE SECTIONS
DESIGN SECTION PROPERTIES



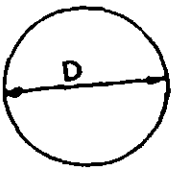
3"x 2"xT

T					
AREA					
$\bar{y}$					
I_x					
I_y					
r_x					
r_y					
r_z (ONE ANGLE)					
LBS / FT (TWO ANGLES)					

LACLEDE STEEL COMPANY SAINT LOUIS, MISSOURI

DRAWING NO. D.10.3 SUBJECT WORLD TRADE CENTER TOWERS
BY L.J.S. DATE 2-6-67 THE PORT OF NEW YORK AUTHORITY
CHKD BY A.C.W. DATE 2-7-67

TRUSS SECTION COMPONENTS
TRUSS WEB SECTIONS
DESIGN SECTION PROPERTIES



DIAMETER					.75
AREA					
RAD. OF GYR.					
LBS/FT					

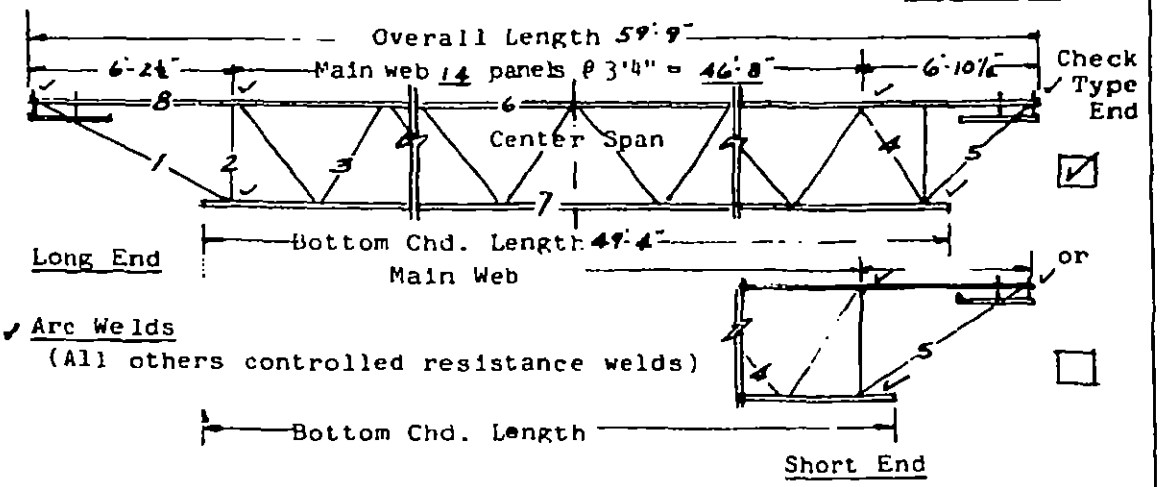
LACLEDE STEEL COMPANY

D105- T 1 -Sheet 1

WORLD TRADE CENTER
FLOOR GRID TRUSSES
DESIGN DATA

Truss Mk. 2C32T1-599

Truss Component Mk. C32T1-599



NOTES:

Main Web - Continuous uniform section throughout Member Mk. 3. (Top chord fillers same section as Main Web - at midpoint 10 center web panels minimum.)

Vertical Struts Mk. 2 - Same size as main web.

End Bearing Struts - Same size as main web.

Composite Type - Webs extend above top chord 4".

MEMBERS REQUIRED PER TRUSS COMPONENT S____ or C ✓

Member	Mk.No.	Grade of Steel	Size	Total Length Member	Weight Member
Top Chord	6-8	A-441	2-2" x 1½" x 0.25" ∡		
Bottom Chord	7	A-36	2-3" x 2" x 0.37" ∡		
Main Web	3	A-36	1.09" DIA		
Compression Web	4	A-441	1.14" DIA		
Vertical End Struts	2	A-36	1.09" DIA		
Long End Diagonal	1	A-441	1.14" DIA		
Short End Diagonal	5	A-441	1.14" DIA		

SPECIAL SECTIONS

(Extended, square ends, etc.)

WORLD TRADE CENTER
FLOOR GRID TRUSSES
DESIGN DATA

TRUSS UNIT MARKED 2C32T1 Refer to drawings ST 101, 6, 7.

Clearspan "L" = 58.92 ft. Spacing = 6.67 ft.

Applicable Total Moment = 4,570,000 inch pounds.

Based on 128 lbs./sq. ft. Total Load "w".

Applicable End Reaction = 25,500 pounds.

Based on 128 lbs./sq. ft. Total Load "W".

Applicable Total Constr. Moment = 1,740,000 inch pounds.

Based on 50 lbs./sq. ft. Construction Load.

Applicable Constr. End Reaction = 10,000 pounds.

Based on 50 lbs./sq. ft. Construction Load.

"V" Shear at End Panel = 22,940 pounds. ED = 3.00 ft.

WEB MEMBER #1 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 22,940 lbs. f_y = 50,000 psi

Slope = 2.65 f_s = 30,000 psi

ℓ = — in. f_{sc} = — psi

Reqd. Area = 2.03 sq. in. Use 2-1.14" DIA Area = 2.04 sq. in.

WEB MEMBER #2 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 22,940 lbs. f_y = 36,000 psi

Slope = 1.00 f_s = — psi

ℓ = 25.5 in. f_{sc} = 13,510 psi

Reqd. Area = 1.69 sq. in. Use 2-1.09" DIA Area = 1.87 sq. in.

WEB MEMBER #3 Distance from End Panel = 4.87 ft.

Applicable Shear V_x = 18,780 lbs. f_y = 36,000 psi

Slope = 1.162 f_s = — psi

ℓ = 29.5 in. f_{sc} = 11,820 psi

Reqd. Area = 1.85 sq. in. Use 2-1.09" DIA Area = 1.87 sq. in.

WEB MEMBER #4 Distance from End Panel = 3.04 ft.

Applicable Shear V_x = 20.340 lbs. f_y = 50.000 psi

Slope = 1.162 f_s = — psi

ℓ = 29.5 in. f_{sc} = 13.850 psi

Reqd. Area = 1.71 sq. in. Use 2 - 1.14" O/A Area = 2.04 sq. in.

WEB MEMBER #5 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 22,940 lbs. f_y = 50,000 psi

Slope = 2.20 f_s = 30,000 psi

ℓ = — in. f_{sc} = — psi

Reqd. Area = 1.68 sq. in. Use 2 - 1.14" O/A Area = 2.04 sq. in.

CHORD MEMBER #6 Consists of 4 - 2" x 1½" x 0.25" Angles

Construction Load Design Area = 3.60 sq. in.

Applicable Moment = 1,740,000 in. lbs. f_y = 50.000 psi

ℓ = 33.375 in. f_s = — psi

r_x = 0.44 in. f_{sc} = 19,380 psi

r_z = 0.31 in. (with fillers in middle 60% of span)

$\frac{\ell}{r_x}$ = 75.8

$\frac{\ell}{2r_z}$ = 53.8

$\frac{f_a}{F_a} + \frac{f_b C_m}{F_b\left(1 - \frac{f_a}{F'_e}\right)}$ = 0.949 less than 1

f_a = 17,250 psi

F_a = 19,380 psi

f_b = 810 psi

F_b = 30,000 psi

F'_e = 25,950 psi

Use 4 - 2" x 1½" x 0.25" ∠'s Area = 3.60 sq. in.

CHORD MEMBER #7 Consists of 4 - 3" x 2" x 0.37" Angles

Total Load Design Area = 7.32 sq. in.

CHORD MEMBER #7 (CONTD.)

Applicable Moment = 4,570,000 in lbs. f_y = 36,000 psi

f_s = 22,000 psi

D_t = 33.00 in. f_{sc} = —— psi

B_{eff} = 64.00 in.

t = 1.00 in.

y_1 = 2.00 in. d_2 = 5.86 in.

y_2 = 1.44 in. d_3 = 22.14 in.

y_3 = 32.44 in. c_1 = 10.30 in.

d_1 = 8.30 in. c_2 = 22.70 in.

$$I_s = \sum [(I_c + A_c d_1^2) + (I_{TCA} + A_{TCA} d_2^2) + I_{BCA} + A_{BCA} d_3^2]$$

$$\bar{y} = \frac{\sum (A_c y_1 + A_{TCA} y_2 + A_{BCA} y_3)}{\sum (A_c + A_{TCA} + A_{BCA})}$$

$\bar{y}$ = 10.30 in.

I_s = 4913 $in.^4$ (2C32T1)

Resisting Moment = $f_s \times \frac{I_s}{c_2}$ = 4,770,000 in. lbs.

Use 4 - 3" x 2" x .037" 4's Area = 7.32 sq. in.

Composite Design Top Chord Check

Total Load Design f_c = 3,000 psi

Applicable Moment = 4,570,000 in. lbs. f'_c = 1,350 psi

$$f'_{cc} = \frac{f'_c}{1.5 I_s} = 640 \text{ psi}$$

CHORD MEMBER #8 Consists of 4 - 2" x 1½" x 0.25" Angles

Area = 3.60 sq. in.

(SAME AS MEMBER 6)

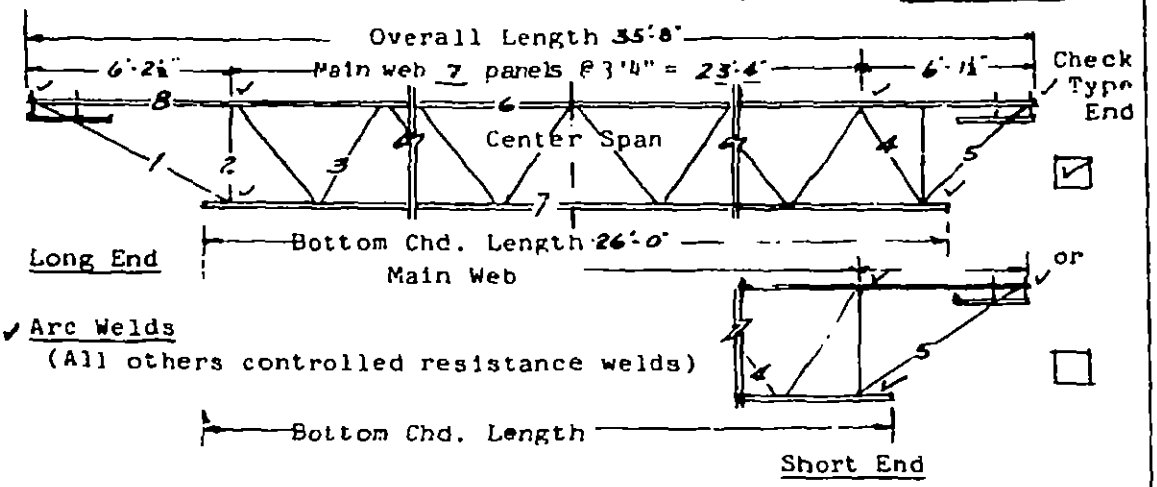
LACLEDE STEEL COMPANY

D105- T 5 -Sheet 1

WORLD TRADE CENTER
FLOOR GRID TRUSSES
DESIGN DATA

Truss Mk. 2C32T5-599

Truss Component Mk. C32T5-599



NOTES:

Main Web - Continuous uniform section throughout Member Mk. 3. (Top chord fillers same section as Main Web - at midpoint NONE center web panels minimum.)

Vertical Struts Mk. 2 - Same size as main web.

End Bearing Struts - Same size as main web.

Composite Type - Webs extend above top chord 4 ".

MEMBERS REQUIRED PER TRUSS COMPONENT S ____ or C ✓

Member	Mk.No.	Grade of Steel	Size	Total Length Member	Weight Member
Top Chord	6-8	A-441	2-2" x 1½" x 0.25" ∡		
Bottom Chord	7	A-36	2-2" x 1½" x 0.25" ∡		
Main Web	3	A-36	0.92" DIA		
Compression Web	4	A-441	0.98" DIA		
Vertical End Struts	2	A-36	0.92" DIA		
Long End Diagonal	1	A-441	0.92" DIA		
Short End Diagonal	5	A-441	0.92" DIA		

SPECIAL SECTIONS

(Extended, square ends, etc.)

LACLEDE STEEL COMPANY

D105- T 5 -Sheet 2

WORLD TRADE CENTER
FLOOR GRID TRUSSES
DESIGN DATA

TRUSS UNIT MARKED 2C32T5 Refer to drawings ST 101, 6.8.

Clearspan "L" = 34.83 ft. Spacing = 6.67 ft.

Applicable Total Moment = 1,920,000 inch pounds. [31' PARTIAL LOADING]

Based on 154 lbs./sq. ft. Total Load "w".

Applicable End Reaction = 16,000 pounds.

Based on 154 lbs./sq. ft. Total Load "w".

Applicable Total Constr. Moment = 585,000 inch pounds.

Based on 46 lbs./sq. ft. Construction Load.

Applicable Constr. End Reaction = 5470 pounds.

Based on 46 lbs./sq. ft. Construction Load.

"V" Shear at End Panel = 14,920 pounds. ED = 3.0 ft.

WEB MEMBER #1 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 14,920 lbs. f_y = 50,000 psi

Slope = 2.65 f_s = 30,000 psi

ℓ = — in. f_{sc} = — psi

Reqd. Area = 1.32 sq. in. Use 2-0.92" O.A. Area = 1.33 sq. in.

WEB MEMBER #2 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 14,920 lbs. f_y = 36,000 psi

Slope = 1.00 f_s = — psi

ℓ = 26.0 in. f_{sc} = 11,200 psi

Reqd. Area = 1.33 sq. in. Use 2-0.92" O.A. Area = 1.33 sq. in.

WEB MEMBER #3 Distance from End Panel = 4.87 ft.

Applicable Shear V_x = 9,920 lbs. f_y = 36,000 psi

Slope = 1.162 f_s = — psi

ℓ = 30.0 in. f_{sc} = 8,750 psi

Reqd. Area = 1.32 sq. in. Use 2-0.92" O.A. Area = 1.33 sq. in.

LACLEDE STEEL COMPANY D105- T 5 -Sheet 3

WEB MEMBER #4 Distance from End Panel = 3.21 ft. (CD = 2.08')

Applicable Shear V_x = 12,570 lbs. f_y = 50,000 psi

Slope = 1162 f_s = — psi

ℓ = 300 in. f_{sc} = 9,970 psi

Reqd. Area = 1.47 sq. in. Use 2-0.98" DIA Area = 1.51 sq. in.

WEB MEMBER #5 Distance from End Panel = 0.0 ft. (CD = 2.08')

Applicable Shear V_x = 15,865 lbs. f_y = 50,000 psi

Slope = 190 f_s = 30,000 psi

ℓ = — in. f_{sc} = — psi

Reqd. Area = 1.01 sq. in. Use 2-0.92" DIA Area = 1.33 sq. in.

CHORD MEMBER #6 Consists of 4 - 2" x 1½" x 0.25" Angles

Construction Load Design Area = 3.60 sq. in.

Applicable Moment = 585,000 in. lbs. f_y = 50,000 psi

ℓ = 33.375 in. f_s = — psi

r_x = 0.44 in. f_{sc} = 19,380 psi

r_z = 0.31 in. (with fillers in middle 60% of span)

$\frac{\ell}{r_x}$ = 75.8

$\frac{\ell}{2r_z}$ = 53.8

$\frac{f_a}{F_a} + \frac{f_b C_m}{F_b\left(1 - \frac{f_a}{F'_e}\right)}$ = 0.410 less than 1

f_a = 7,500 psi

F_a = 19,380 psi

f_b = 748 psi

F_b = 30,000 psi

F'_e = 25,950 psi

Use 4-2" x 1½" x 0.25" A's Area = 3.60 sq. in.

CHORD MEMBER #7 Consists of 4 - 2" x 1½" x 0.25" Angles

Total Load Design Area = 3.60 sq. in.

CHORD MEMBER #7 (CONTD.)

Applicable Moment = 1,920,000 in lbs. f_y = 36,000 psi

f_s = 22,000 psi

D_t = 33.00 in. f_{sc} = —— psi

B_{eff} = 64.00 in.

t = 4.00 in.

y_1 = 2.00 in. d_2 = 2.46 in.

y_2 = 4.44 in. d_3 = 25.66 in.

y_3 = 32.56 in. c_1 = 6.90 in.

d_1 = 4.90 in. c_2 = 26.10 in.

$$I_s = \sum \left[(I_c + A_c d_1^2) + (I_{TCA} + A_{TCA} d_2^2) + I_{BCA} + A_{BCA} d_3 \right]$$

$$\bar{y} = \frac{\sum (A_c y_1 + A_{TCA} y_2 + A_{BCA} y_3)}{\sum (A_c + A_{TCA} + A_{BCA})}$$

$\bar{y}$ = 6.90 in.

I_s = 2826 in.^{4} (2C32TS)

Resisting Moment = $f_s \times \frac{I_s}{c_2}$ = 2,380,000 in. lbs.

Use 4 - 2" x 1½" x 0.25" ∠'s Area = 3.60 sq. in.

Composite Design Top Chord Check

Total Load Design f_c = 3,000 psi

Applicable Moment = 1,920,000 in. lbs. f'_c = 1,350 psi

$$f'_{cc} = \frac{Mc_1}{15 I_s} = 312 \text{ psi}$$

CHORD MEMBER #8 Consists of 4 - 2" x 1½" x 0.25" Angles

Area = 3.60 sq. in.

(SAME AS MEMBER 6)

LACLEDE STEEL COMPANY
STRUCTURAL DETAILS
WORLD TRADE CENTER TOWERS
PORT OF NEW YORK AUTHORITY

Detail No.	Title	Date Transmitted	Approved
ST-101	Typical 32" composite truss web Intermediate Panel - Full Scale		
ST-102	Typical web chord sections 32" composite trusses - Full Scale		
ST-103	Intermediate panel details 24" standard trusses 32" composite trusses - Full Scale		
ST-104	Intermediate panel details 28" composite trusses 32" composite trusses - Full Scale		
ST-105	Corner intersection details Continuity of 32" - 60' span composite trusses (CT3, CT3A and CT4) into 28" composite trusses (CT9) in 35' span - Full Scale		
ST-106	Typical column bearing end detail of 32" composite trusses 2" x 2" damping unit extension Scale ½" = 1"		
ST-106A	Column bearing end detail showing diagonal angle bracing attachment 32" composite trusses Scale ½" = 1"		
ST-106B	Column bearing end detail Typical extended shallow bearing end - 32" composite trusses Scale ½" = 1"		
ST-106C	Column bearing end detail showing damping unit extension for 28" composite trusses 24" standard trusses Scale ½" = 1"		

Detail No.	Title	Date Transmitted	Approved
ST-106D	Column bearing end detail showing diagonal angle bracing attachment 26" composite trusses 24" standard trusses Scale ½" = 1"		
ST-106E	Column bearing end detail Typical extended shallow bearing end 28" composite trusses 24" standard trusses Scale ½" = 1"		
ST-107	32" composite truss details Approximate 60' span Type CT1, CT2, CT3, CT3A and CT4 - Scale 1½" = 1'0"		
ST-108	32" composite truss details Approximate 35' span Type CT5 and CT6 Scale 1½" = 1'0"		
ST-109	28" composite truss details Corner construction Type CT7, CT8 & CT9 Scale 1½" = 1'0"		
ST-110	24" standard truss details 20'0" transverse ST8, ST10, ST11 and ST12 (duct) 13'4" transverse ST13 Scale 1½" = 1'0"		

LACLEDE STEEL COMPANY
FLOOR GRID PANEL & PANEL LOCATIONS
WORLD TRADE CENTER TOWERS
PORT OF NEW YORK AUTHORITY

Detail No.	Title	Date Transmitted	Approved
L-100	Typical floor plan - showing panel designation, truss location, applicable design moments and end reaction for truss design - Scale 1/8" = 1'0"		
L-101	Quarter plan - Typical floor showing panel designation, truss loaction, truss designation and truss web configuration Scale 1/8" = 1'0"		

LACLEDE STEEL COMPANY
DESIGN CALCULATIONS
WORLD TRADE CENTER TOWERS
PORT OF NEW YORK AUTHORITY

Sheet No.	Design Data	Date Transmitted	Approved
D100-1 thru 7	Basic Design Data		
D101	Chord Angle Properties 2" x 1/2" angles		
D102	Chord Angle Properties 3" x 2" angles		
D103	Round Web Properties		
D104	Miscellaneous Section Properties		
D105-T1	Design Data Truss Mk. 2C32T1		
D105-T2	Design Data Truss Mk. 2C32T2		
D105-T3	Design Data Truss Mk. 2C32T3		
D105-T3A	Design Data Truss Mk. 2C32T3A		
D105-T4	Design Data Truss Mk. 2C32T4		
D105-T5	Design Data Truss Mk. 2C32T5		
D105-T6	Design Data Truss Mk. 2C32T6		
D105-T7	Design Data Truss Mk. C28T7		
D105-T8	Design Data Truss Mk. C28T8		
D105-T9	Design Data Truss Mk. C28T9		
D105-T10	Design Data Truss Mk. S24T10		
D105-T11	Design Data Truss Mk. S24T11		
D105-T12	Design Data Truss Mk. S24T12		
D105-T13	Design Data Truss Mk. S24T13		
D105-ET1	Design Data Extended End Truss Mk. 2C32ET1		
D105-ET2	Design Data Extended End Truss Mk. 2C32ET2		
D105-ET3	Design Data Extended End Truss Mk. 2C32ET3		

LACLEDE STEEL COMPANY

Index 5

Sheet No.	Design Data	Date Transmitted	Approved
D105-ET3A	Design Data Extended End Truss Mk. 2C32ET3A		
D105-ET4	Design Data Extended End Truss Mk. 2C32ET4		
D105-ET5	Design Data Extended End Truss Mk. 2C32ET5		
D105-ET6	Design Data Extended End Truss Mk. 2C32ET6		
D105-ET7	Design Data Extended End Truss Mk. C28ET7		
D105-ET10	Design Data Extended End Truss Mk. S24ET10		

WORLD TRADE CENTER
FLOOR GRID TRUSSES
BASIC DESIGN DATA

Based on double truss units. Mark 2CT__ or 2ST__.
Single truss components. Mark CT__ or ST__.

DIMENSIONS:

Unless specifically noted otherwise, see "ST" Details.

Truss clearspan in feet = L. Overall length of truss minus end bearings in feet (2 x 5" = 10"). Example: 59'9" overall length. Clearspan L = 59'9" minus 10" or 58'11" or 58.92'.

Length of member, clear of attachments = "ℓ"

Depth of Truss

Composite type "C" (Measured top of shear member to bottom of lower chord.)

Standard type "S" (Measured out to out of chord members.)

Total depth of composite section = "D_t"

TOLERANCES:

Overall length 1/4"+ or 1/4"-.

Depth 1/8"+ or 1/8"-.

LOADS:

Total load = Live load + Dead load

Applicable for composite design.

Applicable for combined slat and top chord design and bottom chord design.

Construction load = Applicable Dead load

Applicable for top and bottom chord steel design.

Dead load = Actual weight of structural system in pounds per square foot.

Live load = Assigned live load for panel area in pounds per square foot.

Design load in pounds per square foot = "w"

Applicable design load in pounds per foot equals design load in pounds per square foot times spacing of trusses in feet = ... "W"

TOTAL MOMENT:

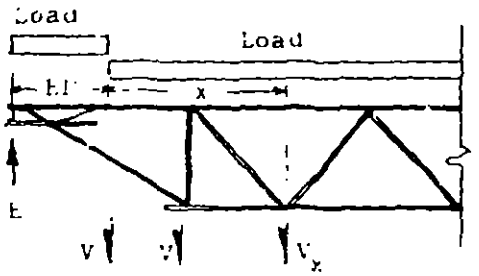
"M" (in inch pounds) = $WL^2 \times 1.5$.

END REACTION:

"R" (in pounds) = "W" x .5 (overall length of truss in feet).

SHEAR:

At first top chord panel in pounds = V = R- (W x ED)

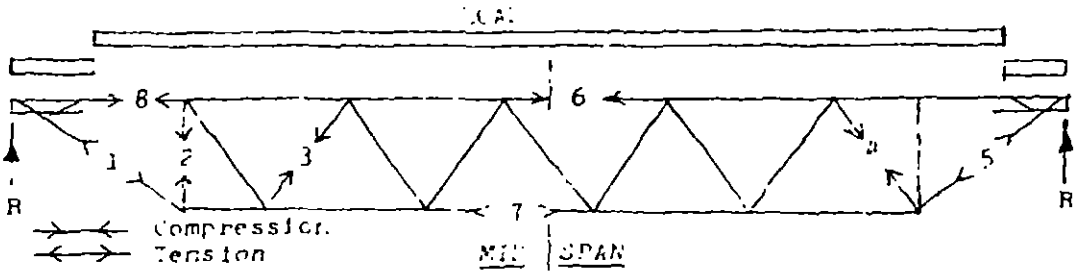


ED = Distance first top chord panel point to truss end.

Shear at other points in pounds = V_x = (R- ED x W)-W (distance to first top chord panel point in feet).

(In no case less than 50% of end reaction "R".)

DESIGNATION OF MEMBERS:



1. End diagonal (long end) tension member
2. First panel vertical (long end) compression
3. Second panel compression diagonal
4. First panel member (short end) compression
5. End diagonal (short end) tension
6. Top chord critical compression member at mid span
7. Bottom chord critical tension member at mid span
8. End top chord compression member (long end)

MATERIALS:

A-36 steel . . . . . 36 ksi minimum yield strength

A-441 modified . . . . . 50 ksi minimum yield strength low alloy "H" Series.

See sheets D101 through D103 for Properties of Sections.

APPLICABLE FORMULAE: Stress Determination (Web or Chord Members)

A-36 steel

(36 ksi minimum yield)

f_y = Minimum Yield Strength 36,000 psi

f_s = Tension 22,000 psi

f_{sc} = Compression for $\ell/r < 127$ $18{,}540 - .574\,(\ell/r)^2$ psi

for $\ell/r > 127$ $\dfrac{149{,}000{,}000}{(\ell/r)^2}$ psi

ℓ = clear distance between attachments

r = least radius of gyration

A-441 steel

(50 ksi minimum yield)

f_y = Minimum Yield Strength 50,000 ksi

f_s = Tension 30,000 psi

f_{sc} = Compression for $\ell/r < 108$ $25{,}750 - 1.108\,(\ell/r)^2$ psi

for $\ell/r > 106 < 200$ $\dfrac{149{,}000{,}000}{(\ell/r)^2}$ psi

Continuous members shall be designed for only axial compressive stress when the panel length clear of attachments does not exceed 24". When the panel length clear of attachments exceeds 24", the top chord shall be designed as a continuous member subject to combined axial and bending stress and shall be of proportion that the quantity -

$$\frac{f_a}{30{,}000} + \frac{f_b}{F_b}$$

does not exceed unity at the panel point, or that the quantity -

$$\frac{f_a}{F_a} + \frac{f_b C_r}{F_b\left(1 - \dfrac{f_a}{F'_e}\right)}$$

does not exceed unity at the mid panel.

Permissible axial unit compressive stress = "F_a"

Permissible bending unit stress = "F_b"

Permissible compressive stress factor (column equation $\dfrac{149{,}000{,}000}{(\ell/r)^2}$ psi) = "F'_e"

Actual axial unit compressive stress = ... f_a

Actual bending unit stress = ... f_b

MAXIMUM SLENDERNESS RATIOS:

Top chord panels (interior) = 85
Top chord end panels = 120
Compression members other than top chord = 200
Tension members = 240

FILLERS OR TIES:

Members in compression composed of two components shall have fillers or ties spaced so that the ratio of ℓ/r of each component shall not exceed the ratio of ℓ/r of the whole member. The minimum "r" shall be used in calculating the critical ratio ℓ/r of any component.

SHEAR CONNECTORS:

Shall be considered to provide a minimum 15 ksi horizontal shear per web end connector imbedded in the concrete. This is for 3,000 psi concrete. (f'_c)

DEFLECTION:

Applicable deflection formula for uniform load.

Maximum deflection $\Delta = \frac{25.88\ (WL^4)}{29{,}000{,}000I}$

COMPOSITE SLAB AND JOIST DESIGN:

Design values

Total depth of combined slab and truss in inches = ... D_t

Effective width of concrete flange in inches equal to 2 x 8t = ... b_{eff}

Distance from top of concrete flange to neutral axis of concrete flange = ... y_1

Distance from top of concrete flange to neutral axis of top chord angles = ... y_2

Distance from top of concrete flange to neutral axis of bottom chord angles = ... y_3

Distance from top of concrete flange to neutral axis of composite section = ... y

Distance from neutral axis of composite section to neutral axis of concrete flange = ... d_1

Distance from neutral axis of composite section to neutral axis of top chord angles = ... d_2

Distance from neutral axis of composite section to neutral axis of bottom chord angles = ... d_3

Distance from neutral axis of composite section to outermost fibers of compression chord = ... c_1

Distance from neutral axis of composite section to outermost fibers of tension chord = ... c_2

Allowable concrete strength f_c = 3,000 pounds psi.

Allowable steel strength = ... f_s

Allowable concrete compressive stress f'_c = 1,350 pounds psi.

Actual concrete compressive stress = ... f'_{cc}

Allowable steel compressive stress = ... f_{cc}

Modular ratio = 15 = ... $\frac{E_s}{E_c}$

SECTION PROPERTIES: (Refer to Sheets D101 through D103)

Moment of inertia of concrete = ... I_c

Moment of inertia of top chord angles = ... I_{TCA}

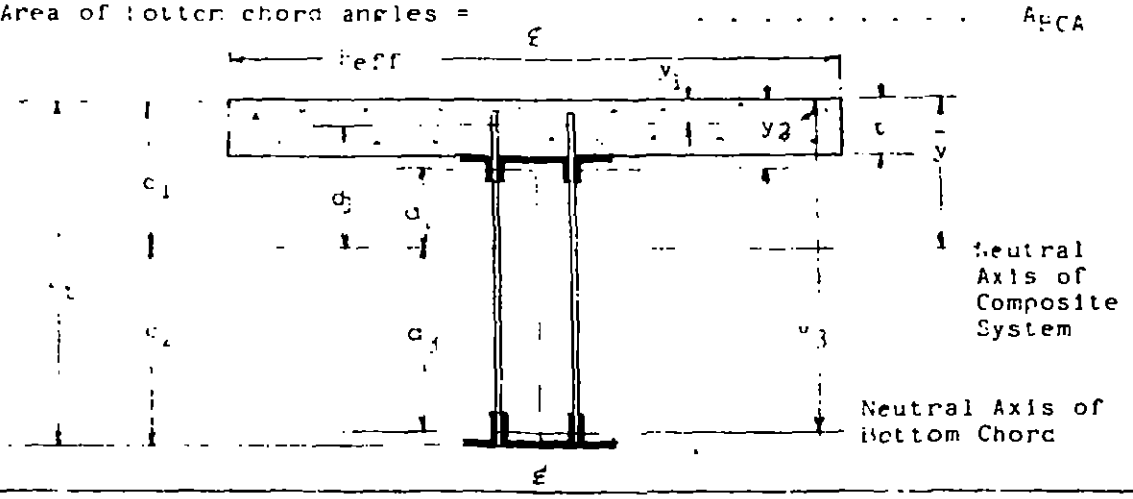
Moment of inertia of bottom chord angles = ... I_{BCA}

Moment of inertia of composite system = ... I_S

Area of concrete flange = ... A_c

Area of top chord angles = ... A_{TCA}

Area of bottom chord angles = ... A_{BCA}



FORMULAE:

Resisting moment = "RM"

Allowable unit stress times the applicable Section Modulus = (applicable f x S).

Section Modulus (about the axis of bending) = $S = \frac{I}{C_1 \text{ or } C_2}$

QUALITY CONTROL AND INSPECTION:

Material Test Reports

Since all steel employed in the fabrication of trusses is produced in the furnaces and mills of Laclede Steel Company, certified mill test reports showing heat numbers, chemistry, and physical properties for all steel components will be provided.

Resistance Welding

Truss panel points will be connected by electronically controlled resistance welding providing two times the strength of the connected members at full design load.

Angle chords of carbon and alloy steel to be of weldable grade with contact surfaces cleaned of scale by shot blasting prior to welding.

Welds to be subject to "on-line" testing by measured hydraulic wedge action tester with spot checking of finished panel point welds by testing in vertical double shear to two times design load value.

Any panel point welds indicated to have less than the established factor for weld shear strength will be arc welded, subsequent to testing.

Full design load tests will be effected on full size and full length truss components by hydraulic loading in a test frame with load measurement by electric load cell and center span deflection check.

Load tests with recorded deflection and recovery data will be made on a minimum of one of each identified truss style involved in the panel construction.

Physical Tension Tests

Tension tests on truss components, chord angles, and webs will be performed on selected sample members included in the normal truss fabrication.

Inspection and Access to Plant

Free access to the plant of the truss manufacturer and the

available inspection and test facilities will be offered the qualified inspectors representing the purchaser for observation of the test and inspection procedures outlined herein.

Any testing requested beyond that identified herein shall be for the account of the purchaser.

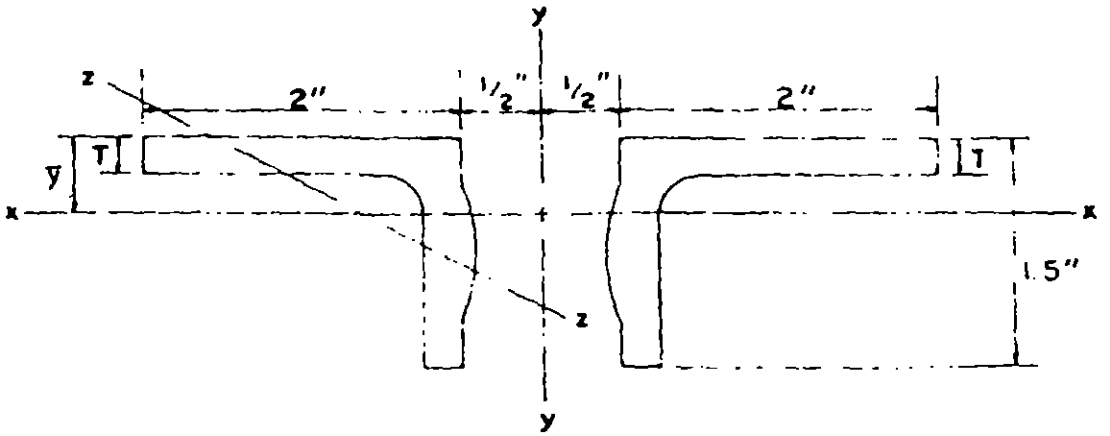
LACLEDE STEEL COMPANY SAINT LOUIS, MISSOURI

DRAWING NO D101 SUBJECT WORLD TRADE CENTER TOWERS

BY L.J.S DATE 2-6-67 THE PORT OF NEW YORK AUTHORITY

CHKD BY A.C.W DATE 2-7-67

TRUSS SECTION COMPONENTS
TRUSS ANGLE SECTIONS
DESIGN SECTION PROPERTIES



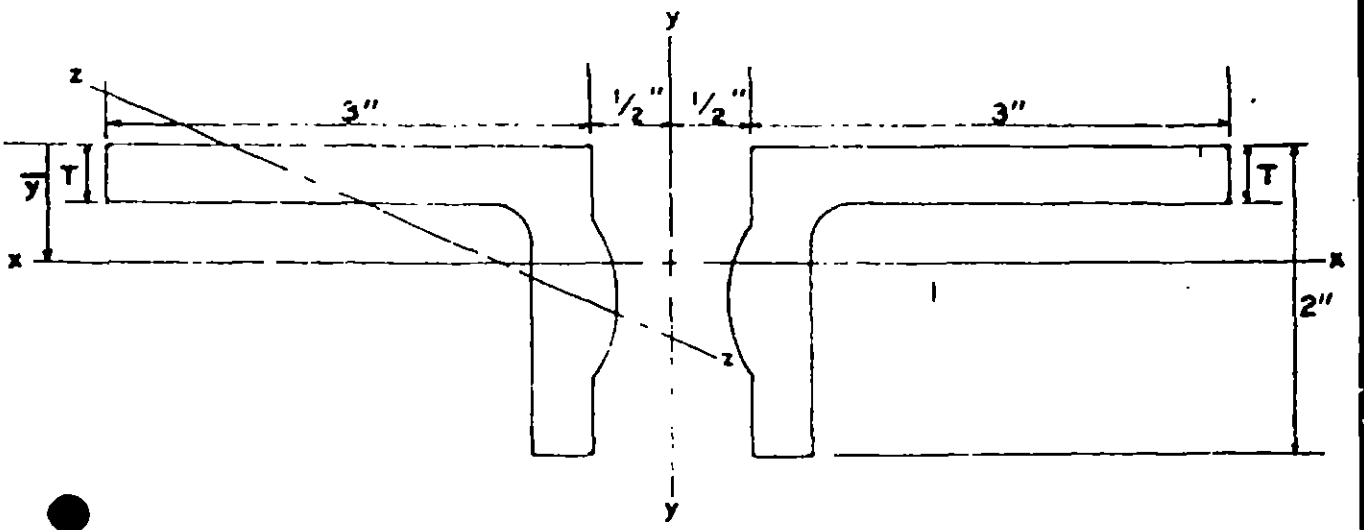
2"x 1½" x T

T					
AREA					
$\bar{y}$					
I_x					
I_y					
r_x					
r_y					
r_z (ONE ANGLE)					
LBS/FT (TWO ANGLES)					

LACLEDE STEEL COMPANY SAINT LOUIS, MISSOURI

DRAWING NO. D102 SUBJECT WORLD TRADE CENTER TOWERS
BY L.J.S. DATE 2-6-67 THE PORT OF NEW YORK AUTHORITY
CHKD BY A.C.W DATE 2-7-67

TRUSS SECTION COMPONENTS
TRUSS ANGLE SECTIONS
DESIGN SECTION PROPERTIES



3" x 2" x T

T					
AREA					
$\bar{y}$					
I_x					
I_y					
r_x					
r_y					
r_z (ONE ANGLE)					
LBS/FT (TWO ANGLES)					

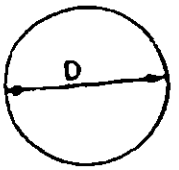
LACLEDE STEEL COMPANY SAINT LOUIS, MISSOURI

DRAWING NO 2103 SUBJECT WORLD TRADE CENTER TOWERS

BY L.J.S DATE 2-6-67 THE PORT OF NEW YORK AUTHORITY

CHKD BY A.C.W DATE 2-7-67

TRUSS SECTION COMPONENTS
TRUSS WEB SECTIONS
DESIGN SECTION PROPERTIES



DIAMETER					
AREA					
RAD. OF GYR.					
LBS/FT					

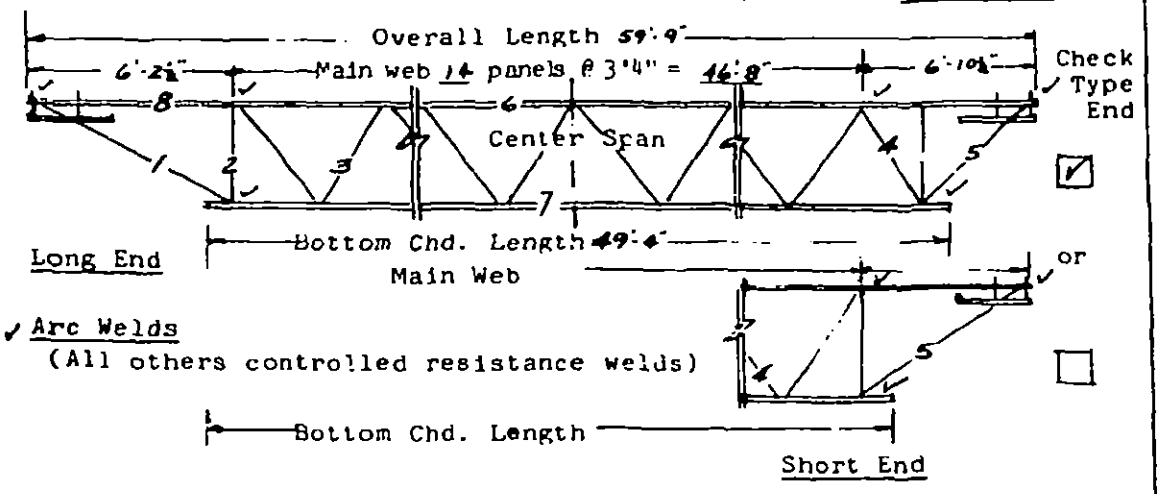
LACLEDE STEEL COMPANY

D105- T 1 -Sheet 1

WORLD TRADE CENTER
FLOOR GRID TRUSSES
DESIGN DATA

Truss Mk. 2C32T1-599

Truss Component Mk. C32T1-599



✓ Arc Welds
(All others controlled resistance welds)

NOTES:

Main Web - Continuous uniform section throughout Member Mk. 3. (Top chord fillers same section as Main Web - at midpoint 10 center web panels minimum.)

Vertical Struts Mk. 2 - Same size as main web.

End Bearing Struts - Same size as main web.

Composite Type - Webs extend above top chord 4 ".

MEMBERS REQUIRED PER TRUSS COMPONENT S____ or C ✓

Member	Mk.No.	Grade of Steel	Size	Total Length Member	Weight Member
Top Chord	6-8	A-441	2-2" × 1½" × 0.25" ∡		
Bottom Chord	7	A-36	2-3" × 2" × 0.37" ∡		
Main Web	3	A-36	1.09" DIA		
Compression Web	4	A-441	1.14" DIA		
Vertical End Struts	2	A-36	1.09" DIA		
Long End Diagonal	1	A-441	1.14" DIA		
Short End Diagonal	5	A-441	1.14" DIA		

SPECIAL SECTIONS

(Extended, square ends, etc.)

WORLD TRADE CENTER
FLOOR GRID TRUSSES
DESIGN DATA

TRUSS UNIT MARKED 2C32T1 Refer to drawings ST 101, 6.7 .

Clearspan "L" = 58.92 ft. Spacing = 6.67 ft.

Applicable Total Moment = 4,670,000 inch pounds.

Based on 128 lbs./sq. ft. Total Load "w".

Applicable End Reaction = 25,500 pounds.

Based on 128 lbs./sq. ft. Total Load "w".

Applicable Total Constr. Moment = 1,740,000 inch pounds.

Based on 50 lbs./sq. ft. Construction Load.

Applicable Constr. End Reaction = 10,000 pounds.

Based on 50 lbs./sq. ft. Construction Load.

"V" Shear at End Panel = 22,940 pounds. ED = 3.00 ft.

WEB MEMBER #1 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 22,940 lbs. f_y = 50,000 psi

Slope = 2. f_s = 30,000 psi

ℓ = — in. f_{sc} = — psi

Reqd. Area = 2.03 sq. in. Use 2-1.14" O.A Area = 2.04 sq. in.

WEB MEMBER #2 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 22,940 lbs. f_y = 36,000 psi

Slope = 1.00 f_s = — psi

ℓ = 25.5 in. f_{sc} = 13,510 psi

Reqd. Area = 1.69 sq. in. Use 2-1.09" O.A Area = 1.87 sq. in.

WEB MEMBER #3 Distance from End Panel = 4.87 ft.

Applicable Shear V_x = 18,780 lbs. f_y = 36,000 psi

Slope = 1.162 f_s = — psi

ℓ = 29.5 in. f_{sc} = 11,820 psi

Reqd. Area = 1.85 sq. in. Use 2-1.09" O.A Area = 1.87 sq. in.

WEB MEMBER #4 Distance from End Panel = 3.04 ft.

Applicable Shear V_x = 20,340 lbs. f_y = 50,000 psi

Slope = 1.162 f_s = — psi

ℓ = 295 in. f_{sc} = 13,850 psi

Reqd. Area = 1.71 sq. in. Use 2-1.14" O.A Area = 2.04 sq. in.

WEB MEMBER #5 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 22,940 lbs. f_y = 50,000 psi

Slope = 2.20 f_s = 30,000 psi

ℓ = — in. f_{sc} = — psi

Reqd. Area = 1.68 sq. in. Use 2-1.14" O.A Area = 2.04 sq. in.

CHORD MEMBER #6 Consists of 4-2"x 1½" x 0.25" Angles

Construction Load Design Area = 3.60 sq. in.

Applicable Moment = 1,740,000 in. lbs. f_y = 50,000 psi

ℓ = 33.375 in. f_s = — psi

r_x = 0.44 in. f_{sc} = 19,380 psi

r_z = 0.31 in. (with fillers in middle 60% of span)

$\frac{\ell}{r_x}$ = 75.8

$\frac{\ell}{2r_z}$ = 53.8

$\frac{f_a}{F_a} + \frac{f_b C_m}{F_b\left(1 - \frac{f_a}{F'_e}\right)}$ = 0.949 less than 1

f_a = 17,250 psi

P_a = 19,380 psi

f_b = 810 psi

P_b = 30,000 psi

F'_e = 26,950 psi

Use 4-2" x 1½" x 0.25" ∠'s Area = 3.60 sq. in.

CHORD MEMBER #7 Consists of 4-3" x 2" x 0.37" Angles

Total Load Design Area = 7.32 sq. in.

CHORD MEMBER #7 (CONTD.)

Applicable Moment = 4,570,000 in lbs. f_y = 36,000 psi

f_s = 22,000 psi

D_t = 33.00 in. f_{sc} = ——— psi

B_{eff} = 64.00 in.

t = 4.00 in.

y_1 = 2.00 in. d_2 = 5.86 in.

y_2 = 4.44 in. d_3 = 22.14 in.

y_3 = 32.44 in. c_1 = 10.30 in.

d_1 = 8.30 in. c_2 = 22.70 in.

$$I_s = \sum [(I_c + A_c d_1^2) + (I_{TCA} + A_{TCA} d_2^2) + I_{BCA} + A_{BCA} d_3^2]$$

$$\bar{y} = \frac{\sum (A_c y_1 + A_{TCA} y_2 + A_{BCA} y_3)}{\sum (A_c + A_{TCA} + A_{BCA})}$$

$\bar{y}$ = 10.30 in.

I_s = 4913 $in.^4$ (2C32T1)

Resisting Moment = $f_s \times \frac{I_s}{c_2}$ = 4,770,000 in. lbs.

Use 4 - 3" x 2" x 0.37" ∠'s Area = 7.32 sq. in.

Composite Design Top Chord Check

Total Load Design f_c = 3,000 psi

Applicable Moment = 4,570,000 in. lbs. f'_c = 1,350 psi

$$f'_{cc} = \frac{M c_1}{.5 I_s} = 640 \text{ psi}$$

CHORD MEMBER #8 Consists of 4 - 2" x 1½" x 0.25" Angles

Area = 3.60 sq. in.

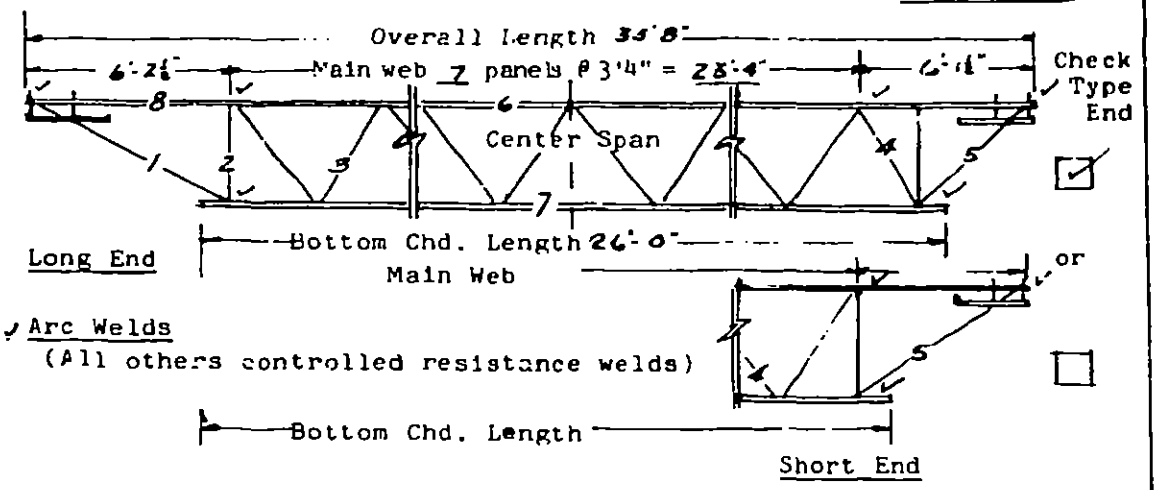
(SAME AS MEMBER 6)

LACLEDE STEEL COMPANY D105- T 5 -Sheet 1

WORLD TRADE CENTER
FLOOR GRID TRUSSES
DESIGN DATA

Truss Mk. 2C32T5 - 358

Truss Component Mk. C32T5-358



NOTES:

Main Web - Continuous uniform section throughout Member Mk. 3. (Top chord fillers same section as Main Web - at midpoint center web panels minimum.) NONE

Vertical Struts Mk. 2 - Same size as main web.

End Bearing Struts - Same size as main web.

Composite Type - Webs extend above top chord 4 ".

MEMBERS REQUIRED PER TRUSS COMPONENT S ____ or C ✓

Member	Mk. No.	Grade of Steel	Size	Total Length Member	Weight Member
Top Chord	6-8	A-441	2-2" x 1½" x 0.25"t		
Bottom Chord	7	A-36	2-2" x 1½" x 0.25"t		
Main Web	3	A-36	0.92" DIA		
Compression Web	4	A-441	0.98" DIA		
Vertical End Struts	2	A-36	0.92" DIA		
Long End Diagonal	1	A-441	0.92" DIA		
Short End Diagonal	5	A-441	0.92" DIA		

SPECIAL SECTIONS

(Extended, square ends, etc.)

LACLEDE STEEL COMPANY D105- T 5 -Sheet 2

WORLD TRADE CENTER
FLOOR GRID TRUSSES
DESIGN DATA

TRUSS UNIT MARKED 2C32T5 Refer to drawings ST 101, 6, 8 .

Clearspan "L" = 34.83 ft. Spacing = 6.67 ft.

Applicable Total Moment = 1,920,000 inch pounds. [31' Partial Loading]

Based on 154 lbs./sq. ft. Total Load "w".

Applicable End Reaction = 18,000 pounds.

Based on 154 lbs./sq. ft. Total Load "w".

Applicable Total Constr. Moment = 585,000 inch pounds.

Based on 46 lbs./sq. ft. Construction Load.

Applicable Constr. End Reaction = 5470 pounds.

Based on 46 lbs./sq. ft. Construction Load.

"V" Shear at End Panel = 14,920 pounds. ED = 3.0 ft.

WEB MEMBER #1 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 14,920 lbs. f_y = 50,000 psi

Slope = 2.65 f_s = 30,000 psi

ℓ = — in. f_{sc} = — psi

Reqd. Area = 1.32 sq. in. Use 2-0.92" DIA Area = 1.33 sq. in.

WEB MEMBER #2 Distance from End Panel = 0.0 ft.

Applicable Shear V_x = 14,920 lbs. f_y = 36,000 psi

Slope = 1.00 f_s = — psi

ℓ = 240.0 in. f_{sc} = 11,200 psi

Reqd. Area = 1.33 sq. in. Use 2-0.92" DIA Area = 1.33 sq. in.

WEB MEMBER #3 Distance from End Panel = 4.87 ft.

Applicable Shear V_x = 9,920 lbs. f_y = 36,000 psi

Slope = 1.162 f_s = — psi

ℓ = 30.0 in. f_{sc} = 8,750 psi

Reqd. Area = 1.32 sq. in. Use 2-0.92" DIA Area = 1.33 sq. in.

WEB MEMBER #4 Distance from End Panel = 3.21 ft. (ED = 2.08')

Applicable Shear V_x = 12,570 lbs. f_y = 50,000 psi

Slope = 1.162 f_s = — psi

ℓ = 30.0 in. f_{sc} = 9,970 psi

Reqd. Area = 1.47 sq. in. Use 2-0.98" O.A. Area = 1.51 sq. in.

WEB MEMBER #5 Distance from End Panel = 0.0 ft. (ED = 2.08')

Applicable Shear V_x = 15,865 lbs. f_y = 50,000 psi

Slope = 1.90 f_s = 30,000 psi

ℓ = — in. f_{sc} = — psi

Reqd. Area = 1.01 sq. in. Use 2-0.92" O.A. Area = 1.33 sq. in.

CHORD MEMBER #6 Consists of 4 - 2" x 1 1/2" x 0.25 Angles

Construction Load Design Area = 3.60 sq. in.

Applicable Moment = 585,000 in. lbs. f_y = 50,000 psi

ℓ = 33.375 in. f_s = — psi

r_x = 0.44 in. f_{sc} = 19,380 psi

r_z = 0.31 in. (with fillers in middle 60% of span)

$\frac{\ell}{r_x}$ = 75.8

$\frac{\ell}{2r_z}$ = 53.8

$\frac{f_a}{F_a} + \frac{f_b C_m}{F_b\left(1 - \frac{f_a}{F'_e}\right)}$ = 0.418 less than 1

f_a = 7,500 psi

F_a = 19,380 psi

f_b = 748 psi

F_b = 30,000 psi

F'_e = 25,950 psi

Use 4 - 2" x 1 1/2" x 0.25" ℓ's Area = 3.60 sq. in.

CHORD MEMBER #7 Consists of 4 - 2" x 1 1/2" x 0.25 Angles

Total Load Design Area = 3.60 sq. in.

CHORD MEMBER #7 (CONTD.)

Applicable Moment = 1,920,000 in lbs. f_y = 36,000 psi

f_a = 22,000 psi

D_t = 33.00 in. f_{ac} = — psi

B_{eff} = 64.00 in.

t = 4.00 in.

y_1 = 2.00 in. d_2 = 2.46 in.

y_2 = 4.44 in. d_3 = 25.66 in.

y_3 = 32.56 in. c_1 = 6.90 in.

d_1 = 4.90 in. c_2 = 26.10 in.

$$I_s = \sum [(I_c + A_c d_1^2) + (I_{TCA} + A_{TCA} d_2^2) + I_{BCA} + A_{BCA} d_3]$$

$$\bar{y} = \frac{\sum (A_c y_1 + A_{TCA} y_2 + A_{BCA} y_3)}{\sum (A_c + A_{TCA} + A_{BCA})}$$

$\bar{y}$ = 6.90 in.

I_s = 2826 $in.^4$ (2C32T5)

Resisting Moment = $f_s \times \frac{I_s}{c_2}$ = 2,380,000 in. lbs.

Use 4 - 2" x 1½" x 0.25" ∠'s Area = 3.60 sq. in.

Composite Design Top Chord Check

Total Load Design f'_c = 3,000 psi

Applicable Moment = 1,920,000 in. lbs. f'_c = 1,350 psi

$$f'_{cc} = \frac{Mc_1}{15I_s} = 312 \text{ psi}$$

CHORD MEMBER #8 Consists of 4 - 2" x 1½" x 0.25" Angles

Area = 3.60 sq. in.

(SAME AS MEMBER 6)

PRINCETON DATAFILM INC.
PRINCETON SERVICE CENTER U S 1 BOX 231, PRINCETON JUNCTION N J 08550 (609) 799 1630

DATE FILMED

AUGUST 27, 1979

I hereby certify that the microphotographs appearing on this reel of film are true copies of the original document

(signed) Joan Chesnes
Camera Operator

Date August 27, 1979

Skiing,
Helle,
Christiansen,
Robertson,
R.C.